Thoughts on Natural Philosophy and the Origin of Life.

By

A. Biddlecombe.

THOUGHTS

ON

NATURAL PHILOSOPHY

(WITH A NEW READING OF NEWTON'S FIRST LAW)

AND THE

ORIGIN OF LIFE

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A. BIDDLECOMBE.

"Plato is my friend, but truth is a greater friend."

"The best of all proofs, is to set out the fact descriptively so that it can be seen to be a fact."—*Oliver Heaviside.*

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FOREWORD.

THE author desires to explain that the method in which he has attacked the great problem with which this treatise deals was settled for him by the fact that it was the discovery of Radium by Madame Curie, and the philosophic explanations of Professors Rutherford and Soddy with regard to radium phenomena, that enabled him to jump to the apprehension of the speed theory of material combination, which has formed the germ from which this sketch of a true natural philosophy has developed.

His acknowledgments and thanks are due to the many eminent men, at home or abroad, living or dead, who have helped him by their books, their delicate and difficult experiments, their wonderful calculations and clever practical work. The living are too truly great to be offended by the efforts of another, however humble, to solve, as far as may be, with their assistance, the great unsolvable. Write with diffidence for the great he must; but their greatness only gives him confidence, because he knows that he is taking his pearls to a right market, where they can be tested and appreciated, where their beauty will please and their purity entrance.

In referring to Sir Isaac Newton the author has no desire to belittle his genius. Sir Isaac was a giant; but like other great men he made mistakes. It would be unwise to accept and perpetuate what is untrue.

The author hopes that he will succeed in interesting the reader, and again cause him to be enraptured with

the wondrous work of nature. If the same feeling is aroused of pleased and awed amazement at the exceeding and marvellous beauty of it all, as has been felt by him while thinking and writing, he will not have published his thoughts in vain.

THOUGHTS ON NATURAL PHILOSOPHY.

THROUGHOUT the ages there have been many *philosophers great and small. The word "Plato" may for convenience be taken to express and include the sum of them. Then, as scientific inquirers, we may well have for our device the well-known quotation: "Plato is my friend, but truth is a greater friend." We are searchers after truth, we revere our teachers; but not all our affectionate reverence or awe of great men, living or dead, can stay us in our quest. Truth alone is sovereign.

We must philosophise, for either we ought to philosophise, or, if we ought not, we must philosophise in order to demonstrate that we ought not to philosophise.

We all agree that the ordinary operations of nature are carried on under the rule of what we term "natural law." It is my endeavour to elucidate that law, or mode of procedure.

The nomenclature adopted is that of the radium experimenters, because I wished to state the case as stated by them. There is not any magic in †names; and it does not much matter what you call a thing so long as the term is clearly defined at the start, and you abide by that term and definition throughout the argument. Scientific terms are but words applied to temporary arrangements of matter caused by the

* An interesting and learned resume of past philosophies may be found in Professor Alfred Weber's admirable "History of Philosophy," published by Longmans, Green & Co.

† The word atom was applied in error to what was supposed to be, uncombined matter. The atomic theory is safe.

speed, weight, and movements of material portions. This is to be remembered in order that we do not get lost in a forest of names, or allow scientific terms to obscure our vision of the reality and cause of things.

Natural philosophy does not belong entirely to scientific experimentalists and mathematicians. When the first have made their delicate and difficult experiments, and the others have worked out their intricate problems, then, if either or both of them commence to construct a system of philosophy, the logicians come in, and it is their high duty to test the reasoning of the philosophers. If that reasoning cannot stand the necessary tests, the philosophy must be cast aside, no matter who may be its author. The work of the logician is necessary, because some of the suggestions of learned men are fit only for *Alice in Wonderland*, where a thing can be a pussy-cat and not a pussy-cat at the same time.

Logic may be described as a means of testing reasoning (or reasoning) by letters; and mathematics as a means of testing reasoning (or reasoning) by figures. They are both efficacious when rightly used; but on a subject of such great complexity as natural philosophy it is well for the mathematician and experimenter to have the assistance of the logician.

The necessity appears to exist of stating definitely (they being essentially different), that M is always M; and that S is always S, in logic, science and philosophy. The magnifying of M enormously, or reducing it greatly, does not alter the fact that it is M; and not any chance or possibility can change it into S. The disassociation of the atom does not make the disassociated portions any the less matter, if reduced to the smallest possible size they are still matter, if by

any possibility they could be made smaller than the smallest possible (an evident absurdity) they would not be. Mass if it could become no mass would be nothing. This basis of rational reasoning must be maintained at all costs, or the so-called logic, science or philosophy becomes mere nonsense.

Physical Theory.—*The enunciation of any one physical law and the rational development of its consequences, constitute a partial physical theory. The assemblage of all the laws which belong to one class of phenomena, forms a more general physical theory; but it will be readily understood that these different laws may be merely corollaries of a single law. The discovery of this single law, when it exists, marks a decided step in the progress of physical science. Thus Newton is supposed to have traced to a single law termed gravitation all the movements of our planetary system, as well as those of bodies which fall to the surface of the earth.

In like manner the different partial theories of optics are rigorous consequences of the properties attributed to a fluid called ether, with which we suppose space to be filled, and whose vibrations serve for the propagation of light and heat.

This work of synthesis has gradually progressed, and these last few years have been marked by very successful efforts in this direction. It should be considered as the true object of physical science in general, and the highest generalization will have been attained when it has been demonstrated that all the physical agents which have hitherto been regarded as distinct, are merely transformations of one and the same primordial agent.

* Deschanel.

Sir Isaac Newton had not the advantage of all the wealth of scientific data to assist him that we possess to-day, and his genius was therefore all the more remarkable. It is not surprising that, at the period in which he lived, and in the difficult circumstances in which he worked, he made mistakes; such as, amongst others, of exalting his idea of gravitation too highly and expecting too much therefrom. Not even he could compel nature to act according to his thoughts, she moveth in her own inimitable way, calculate and write as we will. Our wisdom is to learn of her.

Sir Isaac Newton had his doubts. He at one time thought of endeavouring to account for orbital phenomena by differences of pressure in the ether, but did not publish a theory on the subject.

Matter moves.

In Newton's *Principia* the first law is that "Every body continues in its state of rest or of uniform motion in a straight line, except in so far as it may be compelled by impressed forces to change that state."

Let us transpose the wording as follows:—Every body continues in its state of uniform motion in a straight line, or in its state of rest, except in so far as it may be compelled by impressed forces to change that state.

The reason that the law as transposed is more correctly stated is as follows: It is acknowledged by scientific inquirers that in scientific matters we must reason from the known to the unknown. The only state of rest known to us is a relative and occasional state. Take a book between the two hands, apply an upward and a downward pressure; when the pressure is equal in opposite directions a state of equilibrium

will result, and the book will be at rest. The force that causes this state of rest is energy exercised in opposite directions. What is true of the book is true of other matter. Energy (or material motion) causes the state of rest, therefore energy (or material motion) must be the original thing, and rest a secondary matter or effect. To take the effect as the basis of an argument or system of philosophy, and then invent some imaginary force (which, after all, can only be a name, a word, a no-force) to account for phenomena caused by a force already in existence is fallacious and absurd.

The first law should therefore be that:—Every body continues in its state of uniform motion in a straight line or in its state of rest, except in so far as it may be compelled by motion or force to change those states.

The advantage of this amended law is that you are dealing with known things, and in their right order, and do not have to imagine fanciful ideas.

This amended law agrees with my axiom that "Two portions of matter, moving *adjacent at equal rates of speed along a straight line, must continue to move together as long as their rates of speed remain equal, and they do not receive any interference."

This is the fundamental law of material combination. When they meet other portions of matter and clash, they combine to execute the work of moving the other portions, or are moved, as the case may be; but either way they combine to exercise force and do work.

The birds in the air, the fishes in the water, animals on land, and all moving things illustrate the truth of the axiom. As long as they move adjacent to one

* This includes parallel adjacency.

another, at equal rates of speed, along a straight line, without interference, they keep together.

Matter, having motion, must have speed and direction, and therefore eventually adjacency.

Some may object that if matter had been projected from points along a straight line at sufficient speed it would continue so to progress infinitely, without adjacency and collision; and this no doubt is true. But it is only necessary to state the objection for it to be eliminated from the discussion. Matter has now adjacency and collision, therefore as it could not have had it under the supposed conditions of the objection, it is certain that matter has never (either originally or at any time) taken wholly that mode of progression.

The only other line is the curve, and around any imaginable figure we can draw an imaginary curve, or circle; and for our purpose the curve or curves must permit if necessary of infinite extension from the centre to the circumference. It is therefore clear that the portions of matter must have moved (either originally or always) through points in an imaginary circle or circles. The necessity does not exist to bore the reader with long mathematical calculations, the thing is so simple that the calculations and drawings can be made at will. But it is abundantly clear that as the portions of matter moved through points in the circle or circles they must eventually have had adjacency and collision; and as a result spin, and vortical movement and force, followed by gravitation, electricity and magnetism, together with all the natural phenomena with which we are acquainted, including the sensations of heat and light, as the result of material motion.

Experiment has proved the existence of a consider-

able condensation of energy within the atoms; and we know from observation of radio active and electrical phenomena that the quantity of this energy must be enormous. The energy before the combination into atom, molecule, etc., was once free, and the granules of matter must, consequently, have travelled at terrific speed; and moving through points in a circle or circles must when they clashed have produced so high a temperature as to give by their motion the necessary logical and mathematical basis for the nebular hypothesis of Laplace. A short account of this hypothesis is given in the Encyclopædia Britannica, as follows:—

The nebular theory is a famous hypothesis which has been advanced with the view of accounting for the origin of the solar system. *It is emphatically a speculation; it cannot be demonstrated by observation or established by mathematical calculation. Yet the boldness and the splendour of the nebular theory have always given it a dignity not usually attached to a doctrine which has so little direct evidence in its favour. It will also be admitted that from the very nature of the case a theory of the origin of the solar system must be devoid of direct testimony. All we could expect to find would be features in that system whose existence the theory would account for; or possibly by looking at other systems we might observe them in phases suggesting the early phases of our own system. It is hard to see what other kind of evidence would be attainable. Now as a matter of fact our system does present many most striking features which could be accounted for by the nebular theory, and the theory

*This was written before the publication of my theory.

also derives as much corroboration from the study of other systems as we could reasonably expect. Hence, as all attainable evidence is on the whole in favour of the nebular theory (though here and there there are exceptional phenomena) astronomers have generally regarded this theory with considerable approval.

There are very remarkable features in the solar system which point unmistakably to some common origin of many of the different bodies which it contains. We must at once put the comets out of view. It does not appear that they bear any testimony on either side of the question. We do not know whether the comets are really indigenous to the solar system or whether they may not be merely imported into the system from the depths of space. Even if the comets be indigenous to the system, they may, as many suppose, be merely ejections from the sun, or in any case their orbits are exposed to such tremendous perturbations from the planets that it is quite unsafe from the present orbit of a comet to attempt any estimate of what that orbit may have been countless ages ago. On all these grounds we must put the comets on one side for the present, and discuss the nebular theory without any reference thereto. But even with this omission we still muster in the solar system from two to three hundred bodies almost every one of which pronounces distinctly, though with varying emphasis, in favour of the nebular theory. The first great fact to which we refer is the common direction in which the planets revolve around the sun. This is true not only of the great planets Mercury, Venus, the Earth, Mars, Jupiter, Saturn, Uranus, and Neptune; it is also true of the host of more than two hundred small planets. All these bodies perform

their revolution in the same direction. It is also extremely remarkable that all the great planets and many of the small ones have their orbits very nearly in the same plane, and nearly circular in form. Viewed as a question in probabilities, we may ask what the chance is that out of two hundred and fifty bodies revolving around the sun all shall be moving in one direction. If the direction of movement were merely decided by chance, the probability against such an arrangement is of stupendous magnitude. It is represented by the ratio of unity to a number containing about sixty figures, and so we are at once forced to the conclusion that this remarkable feature of the planetary motions must have some physical explanation. In a minor degree this conclusion is strengthened by observing the satellites. Discarding those of Uranus, in which the orbits of the satellites are highly inclined to the ecliptic, and in which manifestly some exceptional though unknown influences have been at work, we may say that the satellites revolve around the primaries also in the same direction; while, to make the picture complete, we find that the planets, so far as they can be observed, rotate on their axis in the same manner.

The nebular theory here steps in and offers an explanation of this most remarkable uniformity. Laplace supposed that our sun had once a stupendous nebulous atmosphere which extended so far out as to fill all the space at present occupied by the planets. This gigantic nebulous mass, of which the sun was only the central and somewhat more condensed portion, is supposed to have a movement of rotation on its axis. There is no difficulty in conceiving how a nebula, quite independently of any internal motion of its parts, shall

also have had as a whole a movement of rotation. In fact a little consideration will show from the law of probabilities that it is infinitely probable that such an object should really have some movement of rotation, no matter by what causes the nebula may have originated. As this vast mass cooled it must by the laws of heat have contracted towards the centre, and as it contracted it must, according to a well-known law of dynamics, rotate more rapidly. The time would then come when the centrifugal force on the outer parts of the mass would more than counterbalance the attraction of the centre, and thus we would have the outer parts left as a ring. The inner portion will still continue to contract, the same process will be repeated, and thus a second ring will be formed. We have thus grounds for believing that the original nebula will separate into a series of rings all revolving in the same direction with a central nebulous mass in the interior. The materials of each ring would continue to cool and to contract until they passed from the gaseous to the liquid condition. If the consolidation took place with comparative uniformity we might then anticipate the formation of a vast multitude of small planets such as those we actually do find in the region between the orbit of Mars and that of Jupiter. More usually, however, the ring might be expected not to be uniform, and therefore to condense in some parts more rapidly than in others. The effect of such contraction would be to draw into a single mass the materials of the ring, and thus we would have a planet formed, while the satellites of that planet would be developed from the still nascent planet in the same way as the planet itself originated from the sun. In this way we account most simply for the uniformity

in the direction in which the planets revolve and for the mutual proximity of the planes in which their orbits are contained. The rotation of the planets on their axes is also explained, for at the time of the first formation of the planet it must have participated in the rotation of the whole nebula, and by the subsequent contraction of the planet the speed with which the rotation was performed must have been accelerated.

There is quite a different method of approaching the subject, which leads in a very striking manner to conclusions practically identical with those we have just sketched. We may commence by dealing with the sun as we find it at the present moment, and then reasoning back to what must have been the case in the earlier epochs of the history of our system. The stupendous daily outpour of heat from the sun at the present time is really, when properly studied, a profound argument in support of the nebular theory. The amount of the sun's heat has been estimated. We receive on the earth less than one two-thousand-millionth part of the whole radiation. It would seem that the greater part of the rest of that torrent flows away to be lost in space. Now what supplies this heat? We might at first suppose that the sun was really a mightily heated body radiating out its heat as white hot iron does, but this explanation cannot be admitted in face of the notorious fact that there is no historical evidence that the sun is growing colder. We have not the slightest reason to think that the radiation from the sun is measurably weaker now than it was a couple of thousand years ago, yet it can be shown that, if the sun were merely radiating heat as simply a hot body, then it would cool some degrees every year, and must have cooled many thousands of

degrees within the time covered by historical records. We therefore conclude that the sun has some other source of heat than that due simply to incandescence. We can also conceive that the heat of the sun might be supplied by something analogous to combustion. It would take 20 tons of coal a day burned on each square foot of the sun's surface to supply the daily radiation. Even if the sun were made of one mass of fuel as efficient as coal, that mass must be entirely expended in a few thousand years. We cannot therefore admit that the source of the heat in the sun is to be found in any chemical combination taking place in its mass. Where then can we find an adequate supply of heat? Only one external source can be named: the falling of meteors into the sun must yield some heat just as the flash of a shooting star yields some heat to our atmosphere, but the question is whether the quantity of heat obtainable from the shooting stars is at all adequate for the purpose. It can be shown that unless a quantity of meteors in collective mass equal to our moon were to plunge into the sun every year the supply of heat could not be sustained from this source. Now there is no reason to believe that meteors in anything like this quantity can be supplied to the sun, and therefore we must reject this source as also inadequate.

The truth about the sun's heat appears to be that the sun is really an incandescent body losing heat, but that the operation of cooling is immensely retarded owing to a curious circumstance due jointly to the stupendous mass of the sun and to a remarkable law of heat. It is of course well known that if energy disappears in one form it reappears in another, and this principle applied to the sun will explain the famous difficulty.

As the sun loses heat it contracts, and every pair of particles in the sun are nearer to each other after the contraction than they were before. The energy due to their separation is thus less in the contracted state than in the original state, and as that energy cannot be lost it must reappear in heat. The sun is thus slowly contracting; but as it contracts it gains heat by the operation of the law just referred to, and thus the further cooling and further contraction of the sun is protracted until the additional heat obtained is radiated away. In this way we can reconcile the fact that the sun is certainly losing heat with the fact that the change in temperature has not been large enough to be perceived within historic times.

It can be shown that the sun is at present contracting, so that its diameter diminishes four miles every century. This is of course an inappreciable distance when compared with the diameter of the sun, which is nearly a million of miles, but the significance for our present purpose depends upon the fact that this contraction is always taking place. A thousand years ago the sun must have had a diameter 40 miles greater than at present, ten thousand years ago that diameter must have been 400 miles more than it is now, and so on. We cannot perhaps assert that the same rate is to be continued for very many centuries, but it is plain that the further we look back into past time the greater must the sun have been.

Dealing then simply with the laws of nature as we know them, we can see no boundary to the growth of the sun as we look back. We must conceive a time when the sun was swollen to such an extent that it filled up the entire space girdled by the orbit of Mercury. Earlier still the sun must have reached to

the Earth. Earlier still the sun must have reached to where Neptune now revolves on the confines of our system, but the mass of the sun could not undergo an expansion so prodigious without being made vastly more rarefied than at present, and hence we are led by this mode of reasoning to the conception of the primæval nebula from which our system has originated.

Considering that our sun is but a star, or but one of the millions of stars, it becomes a question of great interest to see whether any other systems present indication of a nebulous origin analogous to that which Laplace proposed for the solar system. In one of his most memorable papers, Sir W. Herschel marshals the evidence which can be collected on this point. He arranges in this paper a selection from his observations on the nebula in such a way as to give great plausibility to his view of the gradual transmutation of nebulæ into stars. Herschel begins by showing us that there are regions in the heavens where a faint diffused nebulosity is all that can be detected by the telescope. There are other nebulæ in which a nucleus can be just discerned, others again in which the nucleus is easily seen, and still others where the nucleus is a brilliant star-like point. The transition from an object of this kind to a nebulous star is very natural, while the nebulous stars pass into the ordinary stars by a few graduated stages. It is thus possible to enumerate a series of objects beginning at one end with the most diffused nebulosity and ending at the other with an ordinary fixed star or group of stars. Each object in the series differs but slightly from the object just before it and the object just after it. It

seemed to Herschel that he was thus able to view the actual changes by which masses of phosphorescent or glowing vapour became actually condensed down into stars. The condensation of a nebula could be followed in the same manner as we can study the growth of the trees in the forest, by comparing the trees of various ages which the forest contains at the same time. In attempting to pronounce on the evidence with regard to Herschel's theory, we must at once admit that the transmutation of a nebula into a star has never been seen. It is indeed very doubtful whether any changes of a nebula have ever been seen which are of the same character as the changes Herschel's theory would require. It seems, however, most likely that the periods of time required for such changes are so stupendous that the changes accomplished in a century or two are absolutely inappreciable.

The nebular theory is a noble speculation supported by plausible argument, and the verdict of science on the whole subject cannot be better expressed than in the words of Newcomb:—"At the present time we can only say that the nebular hypothesis is indicated by the general tendencies of the laws of nature, that it has not been proved to be inconsistent with any fact, that it is almost a necessary consequence of the only theory by which we can account for the origin and conservation of the sun's heat, but that it rests on the assumption that this conservation is to be explained by the laws of nature as we now see them in operation. Should any one be sceptical as to the sufficiency of these laws to account for the present state of things, science can furnish no evidence strong enough to overthrow his doubts until the sun shall be found growing

smaller by actual measurement, or the nebulæ be actually seen to condense into stars and systems."

The phenomena of nebulæ is so interesting and important that further details may be acceptable to the reader.

*The Sun, and, by the same process of reasoning, the stars, would thus appear to have originated in extended volumes of tenuous gas, and to be fated in the end to be degraded into cold inert masses. These conclusions being accepted, it would appear probable that both of these conditions would be at the present time represented among celestial bodies, for even upon the extreme assumption that all of them were †created at the same time and in the same stage of development, it would follow that, since they differ enormously in mass, they would cool and therefore pass through their life stages at different rates. It becomes, therefore, of great interest to inquire whether there exist in celestial space extensive bodies of gas, and whether there exist dark stars. The answer is clear: astronomical observation has revealed both.

There can be little doubt that the earliest stage of star-life is represented in, at any rate many of, the nebulæ. The nebulæ appear as faint clouds of light, and are distributed in thousands over the face of the heavens. The greater number are excessively faint, their very detection demanding the aid of the highest optical power; while two only, and those just hovering upon the verge of vision, are visible to the eye upon the darkest and clearest nights. These are the glorious objects in the constellations of Andromeda and Orion, the one in Orion being the more impressive of the two.

*A. H. Fison. †Evolved.

The Great Nebula of Orion is situated near the centre of a line of faint stars that trail southward from the middle of a line formed by the three bright ones that constitute the "belt" of the familiar winter constellation Orion. Visible to the naked eye under favourable conditions as a faint mist—

> A single misty star,
> Which is the second in a line of stars,
> That form a sword beneath a belt of three;—

its cloudy nature clearly revealed in a hand telescope or a good field-glass; when viewed through a telescope of large light-grasping power it becomes one of the most impressive of natural objects, though the vast extension of the heavens into which its wreaths are thrown, and the abundance of delicate detail permeating the whole, have only become revealed in recent records of the photographic plate.

The Nebula of Orion appears through a fine telescope as a faint green haze, suggesting a light cloud floating in celestial space, in form not very unlike that of the profile of a fish's mouth. The whole is composed of clouds of light of different degrees of brightness, some of extreme fantastic, and not a few of highly suggestive forms. It is in the perception of these that the photographic plate has demonstrated, as powerfully as in any of its applications, its great superiority over the eye in its capacity of appreciating the faintest shades of light. Structure is revealed throughout the whole nebula by the manner in which streams of luminous matter are directed from a brilliant and nearly central region in close proximity to the mouth-like bay of dark sky, the importance of this region being emphasized by the occurrence in it of a remarkable group of stars—"the trapezium of Orion"—and in the symmetrical arrangement of many

of the cloud-forms with reference to it. Many stars are scattered over the picture; that those of the trapezium are actually involved in the glowing wreaths of the nebula itself, and do not owe their appearance in it to the effect of optical projection, either by their lying by chance in the line of sight towards the nebula, or by being visible through its transparent substance while actually far beyond, is rendered overwhelmingly probable from their position with reference to the cloud-forms, as well as by certain relations that have been shown to exist between their analysed light and that of the immediately surrounding nebula, in the spectroscopic researches of Sir William Huggins.

The diffuse character of the outlines of the nebula renders it impossible to apply to it such delicate measurements of direction as are necessary for the determination of the parallax. For this reason its distance cannot be directly investigated. The stars of the trapezium have, however, shown no parallax; from this it becomes possible to assign roughly a minimum limit beyond which they, and therefore in all probability the nebula, must lie. Such distance can scarcely be less than a million times that of the Sun. To appear of its vast extent, even at this, the most modest estimate, its glowing clouds must extend over such abysmal depths, that the whole of the Solar System if plunged into it would become contemptible in its utter insignificance.

The Nebula of Orion is a noble example of an "irregular nebula." That of Andromeda, in its regular ellipticity of outline, in the uniformity in the central condensation of its light, and in the system of elliptical rings by which it is enveloped, forms so strong a contrast with it that it is difficult to regard the two as

objects belonging to the same class. Other nebulæ display a spiral structure; others again appear as fairly sharply defined planetary discs; while the majority are to all appearance nothing more than minute structureless clouds of flocculent light.

In the early period of their discovery, a discovery that followed naturally upon Galileo's first application of the telescope to astronomical observation in 1609, nebulæ were regarded as diffusions of a lucid medium shining by its own inherent lustre. In 1780, the year that marked the commencement of Sir William Herschel's classical researches upon them, less than 150 were known; but as the result of those researches, which extended over a period of twenty-one years, their number had been increased to close upon 2,500. By their extended distribution in space, as well as by the detailed structure revealed in many of them by Herschel's observations, the nebulæ had acquired a new importance in the system of the Universe.

From a not altogether satisfactory deduction from the universality of gravitation, an extension of natural law that his own discovery of the mutual revolution of the components of double stars went far to establish, Herschel was led, in the earlier period of his researches, to reject the generally received view regarding the nature of nebulæ, and to substitute for it one according to which they were clusters of stars, the component stars being too faint, by reason, it was supposed, of excessive distance, for their individuality to be recognized. While maintaining this view with regard to the constitution of some nebulæ, Herschel, however, subsequently reverted to the former hypothesis to account for many of them, these including the Nebula of Orion, regarding them as "extensions of a shining fluid of a nature unknown to us." He

further framed a first consistent scheme of stellar evolution, in suggesting that individual stars and clusters of stars were formed by the condensation of this nebula substance by the power of gravitation.

During the first half of the present century scientific opinion entirely reverted to the earlier of Herschel's views. Changes in the outlines of certain nebulæ, and the absence of structure in others of the "planetary" class, both of which Herschel, thinking that he had established by observation, had advanced in support of his later views, failed to receive confirmation in their examination by later astronomers. As with increased telescopic power many objects classed as nebulæ were one by one resolved into collections of stars, the conviction became increasingly strong, that, with sufficiently refined means, all would ultimately succumb: and when at length, in 1850, the Great Nebula of Orion was thought, from its appearance in the gigantic telescope of Lord Rosse, to show indications of breaking into clouds of stars, the riddle of the nebulæ appeared to be approaching its last solution. As clusters of stars the nebulæ found ready place in the speculations of many astronomers, whose minds, in consequence of the perfection displayed in the relations between the Sun and planets, had become powerfully impressed with the conception of a system as an essential unit in the construction of the universe. The planets, with their attendant satellites, formed systems, fair images of the grander Solar System, in which they were included. Each star was regarded as a sun, the centre of a planetary system of its own. Visible isolated stars formed with our Sun a larger but essentially similar system or "galaxy," in which it was even conjectured that all members might revolve round a central orb; while nebulæ were other systems of suns,

external galaxies, awfully remote from our galaxy and from each other; oases of active energy scattered through space. The demolition of this stupendous conception by later researches has been advanced as supplying the only instance in which astronomical discovery has failed to reveal in the actual a more majestic scheme than had previously been idealized in the boldest imagination.

While, however, the colossal reflector of the Earl of Rosse was engaged, it was fondly believed, in finally establishing the nebulæ as clusters of faint stars, the researches of Angstrom, Bunsen, Kirchhoff, and others were placing upon a firm foundation the principles of a new science that was shortly to enter the arena, with the result of utterly confounding general expectation. In the year 1672 Sir Isaac Newton had shown that, upon passing a ray of sunlight through a glass prism, it became separated into its constituent colours, by reason of the fact that all rays are deflected or "refracted" on traversing the prism, but that rays of different colours are refracted to different degrees. After the lapse of a century and a half the study of the analysis of light was resumed and the instrumental means greatly improved by Fraunhofer of Munich; and, by the labours of Kirchhoff and Bunsen, the spectroscope assumed its place as a powerful instrument of research about the year 1860.

The spectroscope is essentially an instrument whereby light consisting of a mixture of colours is, after entering the instrument by a narrow slit, resolved into its constituent colours by a prism, or occasionally by an equivalent "diffraction grating." The separated colours are in either case spread out into a tinted band or "spectrum." About the middle of the present century observations with the spectroscope had in-

dicated that there was a remarkable difference between light emitted by a glowing gas and that radiated from an incandescent solid or liquid body. With light emanating from an incandescent solid or liquid, such as that emitted by a glowing mass of white-hot metal, or by a gas flame in which the greater part of the luminosity is due to incandescent clouds of soot deposited in the flame from the decomposition of the gas under the intense heat of combustion, and, with a limitation to be noticed subsequently, that from the Sun and from the great majority of the stars, the spectrum consists of a continuous band in which all the colours of the rainbow are represented, each passing into the next by insensible gradations, while red and violet occupy the extreme positions. In the light from a glowing gas, however, at any rate when the density of the gas is not excessive, this is not the case, the light being now resolved into a series of clearly-defined and separate colours, which appear in the spectroscope as bright lines of coloured light separated by dark intervals; the lines are, in fact, images of the slit by which the light enters the instrument, a separate image being formed by each of the colours present. The light from the flame of a spirit-lamp which has acquired a strong yellow tint by sprinkling a trace of common salt upon the wick, is, for instance, resolved into two closely coincident shades of yellow, indicated in the spectroscope by the appearance of a pair of closely adjacent yellow lines; and the peach-coloured glow emitted by hydrogen gas when rendered luminous by a discharge of electricity through it, gives rise to the appearance of several coloured lines, of which a crimson and an emerald-green appeal most strongly to the eye.

In the year 1864, Sir William Huggins first applied

the spectroscope to the study of the nebulæ, the particular one selected being a small but comparatively bright object in the constellation of the Dragon. The light from the nebula was condensed upon the slit of the spectroscope by the object-glass, eight inches in diameter, of an astronomical telescope; and at the first glance, the examination of the spectrum showed it to be characteristic of the light emitted from a glowing gas, since it consisted, not of a continuous band, but of three separated lines, all of them being of a green colour. The luminous matter of the nebula consisted, therefore, not of a host of stars, but of incandescent gas; and the more matured views of Sir William Herschel were established upon a sound scientific basis.

During the four years following this observation Huggins subjected the light from seventy other nebulæ to analysis; and of them about one-third, including the Great Nebula in Orion, proved to be gaseous. The remaining two-thirds yielded "continuous" spectra, spectra in which all shades of colour were represented, and might, therefore, so far as spectroscopic evidence was concerned, consist of systems of stars, of gas possessing comparatively high density, or of gas in an incipient stage of condensation. The structure of some of these as revealed by the photographic plate lends strong support to the last hypothesis; in the Great Nebula in Andromeda, for instance, it is scarcely possible not to recognize the process of condensation as actually in progress. Nearly one-half of the nebulæ owe their luminosity to the presence in them of glowing gas.

It is difficult not to see in the gaseous nebulæ the stuff of which future stars will be made. Granting that their substance is subject to the law of gravitation,

it appears certain that in coming ages their glowing matter must, under its influence, be drawn towards centres of condensation; the smaller and more symmetrical of the nebulæ possibly developing into single stars, but such majestic collections of cloudy structures as are revealed in Orion being more probably the origin of hosts of separate suns.

The Nebulæ, and other material phenomena, are the result of matter in motion, or material motion.

Material motion gives the sensation of heat, and is called "energy." The word "energy" is only a name given to material motion.

Electricity and magnetism are material motion in special forms or modes, and only in operation when material motion takes those forms or modes. This accounts for the fact that in nature there may be heat without electricity and magnetism, and that where there is electricity and magnetism there is heat. It also accounts for the apparently occasional character of electricity and magnetism, on which subjects much has to be said later on.

*Gravitation, *as conceived in the Newtonian philosophy,* does not exist in its entirety—it is, in that sense, imaginary and fallacious; but, as the force that keeps

*By the Newtonian I mean that philosophy that starting from a state of rest imagines the motion of matter to have been caused by the mutual attractions of its smallest portions. Newton erred in making his idea of gravitation inclusive and universal, had he confined it to the action of matter from the combined stage to larger masses, and explained that it was caused by vortication, his philosophy would have been sound.

"Huygens, who above all other men was qualified to appreciate Newton's philosophy, rejected the doctrine of gravitation as existing between the individual particles of matter, and received it only as an attribute of the planetary masses." Memoirs of Sir Isaac Newton, by Sir David Brewster. If by particles Huygens meant the smallest portions of matter, he was correct.

the planets in their orbits is centripetal, the mathematical problems stand. So for the future you may trust Newton's mathematics, but not his philosophy. Objects vorticate towards the earth as a result of the action of the ether, while they gravitate to it, as a result of that action, in a somewhat similar manner to the way in which a piece of wood floating in the water may be said to gravitate towards the shore by the action of the incoming tide. The gravitation is caused by the vortication.

Take a bar magnet, and break it as often as you will, the portions are still magnetic, leading to the conclusion that the molecules are magnetic, and exert such an influence upon the ether by their motion as to drag smaller objects to the magnet. Magnify one of these tiny magnets to the size of the earth, and imagine a man standing upon it; he sees that smaller objects approach it, and wishing to find a cause that will account for the phenomena, and not being able to see the ether, he imagines the fictions of the inherent attraction of matter, and consequent action at a distance. But his supposition is not according to fact, it is material motion in and by the mass and the ether, and action by contact, that accounts for the phenomena. Combine the varied motions of corpuscles, atoms, molecules, stars, suns, planets, ether, etc., and fictions are quite unnecessary and objectionable, the facts are sufficiently stupendous and adequate to produce the inevitable and natural results.

Newton in his letter to Bentley wrote as follows: —"It is inconceivable that inanimate brute matter should, without the mediation of something else which is not material, operate upon and affect other matter without mutual contact, as it must do if gravitation in

the sense of Epicurus be essential and inherent in it. That gravity should be innate, inherent, and essential to matter, so that one body can act upon another at a distance through a vacuum, without the mediation of anything else, by and through which their action and force may be conveyed from one to another, is to me so great an absurdity, that I believe no man, who has in philosophical matters a competent faculty of thinking, can ever fall into it."

Inherent attraction (or gravity) of the smallest portions of matter (with or without the mediation of something else) is a mere fiction, based on the attraction caused by vortication. If Newton had confined his philosophy to the action of matter from what has been called the atomic stage, onward to larger masses his philosophy would have been unassailable, although it would have been a more full and correct explanation to have said that the gravitation was caused by vortication. The error has been in stating gravitation to be an inclusive and *universal law, whereas it only applies when combination and vortication have been set up in nature.

It is interesting to note that on this subject both Descartes and Newton were right, in the main, and up to a certain point, allowing for what we now can see was erroneous. Newton in his idea (up to a certain point) of gravitation; and Descartes (with a margin

*"The great discovery which characterizes the Principia, is that of the principle of universal gravitation." Memoirs of Sir Isaac Newton, by Sir David Brewster. My contention is that it is not universal. *i e.*, pertaining to all things, without exception, but is only true when combination and vortication have been set up in nature, and I appear to have the support of Huygens, Descartes and other great philosophers.

for errors) in his idea of vortices. It is the Vortices not of Descartes, but of nature that causes the gravitation (or rather vortication) that Newton sought to mathematically demonstrate, and that experiment and observation has confirmed. To Descartes and Clerk Maxwell must ever belong the honour of drawing attention thereto and doing their utmost to make clear the same. But Vortices must be formed. How? Matter having motion, must have direction and eventually adjacency, and collision. The collisions give variety to the movements, and amidst the many clashings some portions will take the necessary spin (travelling with others of the same speed) to give the vortical force and produce the inevitable vortices in the ether, as in the case of magnets. All things that have reached the molecule stage are naturally more or less magnetic (see Faraday), there are many angles of spin or revolution and rates of speed, and consequently many degrees of vortical power. The larger masses such as suns, etc., rushing and whirling through the ether (and interwhirling in themselves) produce immense vortices in the ether. They must do so because you cannot have two portions of matter filling the same portion of space at the same time. The rushing masses must displace the smaller portions of matter that they meet, and with which they clash; and the ether must flow into the network of holes made by the passing sun or planet. These vortices, or stresses in the ether, assist to keep the suns, planets, etc., in their orbits.

This theory regards motion as a condition of matter, and rest as a relative effect of material motion exerted in different ways or directions. From this material motion all natural phenomena proceed.

In order to enable us to consider what follows with greater ease, let us construct a mental spring-board in the form of a syllogism, as follows:—

1. Material combinations are the result of material motion.

2. Material motion must have speed.

3. Therefore material combinations are the result of speed of material portions.

THE SPEED THEORY.

RADIUM, discovered by Madam Curie, is a great aid to the solution of the Riddle of the Universe.

One of the greatest generalisations of science (termed the conservation of energy) teaches that energy, however it may be changed from one form of force into another, is never destroyed or originated.

Another great generalisation (the *persistence of matter) teaches that no substance comes into existence out of nothing, and no substance is ever annihilated.

Both of these great laws Radium, on its first discovery, appeared to contradict, by, apparently, continuously throwing off heat, or energy, without getting colder, although the dissipated energy was not replaced from external sources; and it appeared to continuously emanate matter from itself without growing less.

This extraordinary behaviour naturally excited great interest in scientific minds, and set the experimenters at work. Among that able and learned band of men Professors Rutherford and Soddy devoted their attention to the study of Radium and kindred radio-active substances. After most painstaking and ingenious researches, they were rewarded by being able to devise and publish an explanation showing that Radium, like other substances, confirmed the great theories of the conservation of energy and the persistence of matter.

†The explanation was that some of the atoms of Radium were constantly disintegrating into smaller

*Read Büchner's "Force and Matter."

†Dr. W. Hampson's "Radium explained."

portions of matter, and that the energy continually developed by the Radium is due to the liberation of the energy contained in the atom in the form of interatomic vibration of the corpuscles of which the atoms consist.

This explanation appeared at first to some to be revolutionary, because it had been held and taught by great authorities that the atom was the ultimately minute and inseparable portion of matter. Nevertheless, it has been thought that a readjustment was necessary, which conceived the atoms to be separable into minute, and still further separable into minuter, parts; and that the elements (less than one hundred in number) resolved for us by the chemists must be conceived as complex products derived from fewer and simpler radicals, possibly only one. The explanation of Professors Rutherford and Soddy, which is growing in acceptance, confirms this idea. Sir William Ramsay's work in connection with this subject is well known.

Radium, then, consists of atoms of matter; these atoms are built up of corpuscles, and these corpuscles possibly of minute granules of matter moving and revolving at a tremendous speed; and some of the corpuscles disintegrate, and shoot forth from the atom minute portions of matter at enormous speed.

Here we approach the discovery of what appears to be a great truth of far-reaching and immense importance.

The things that give its character to Radium are the speed, weight, and movements of its atoms, corpuscles, and granules.

This is the great truth, and appears to be the key

to the Riddle of the Universe—viz., that the *speed and weight of the granules, corpuscles, atoms, and molecules, and the peculiarities of movement resulting from that speed and weight, give to substances their distinguishing characteristics, and account for all natural phenomena.

[One of the most fundamental of the facts concerning the †dissociation of matter is "the emission into space, from bodies undergoing dissociation, of ‡immaterial particles animated by a speed capable of equalling and even of often exceeding a third of the speed of light. That speed is immensely superior to any we can produce by the aid of the known forces at our disposal. This is a point which must be steadily kept in mind from the first. A few figures will suffice to make this difference evident.

A very simple calculation shows, in fact, that to give a small bullet the speed of the particles emitted by matter in process of dissociation would require a firearm capable of containing one million three hundred and forty thousand barrels of gunpowder. As soon as the immense speed of the particles emitted was measured by the very simple methods I describe elsewhere, it became evident that an enormous amount of energy is liberated during the dissociation of atoms.

The radio-activity is above all manifested under the influence of external agents—light, heat, chemical forces, etc.—it is comprehensible that we should seek for the origin of this proved energy among these

*Speed, and movement, may take many forms; and for weight you may read mass.

†Dr. Gustave Le Bon's "Evolution of Matter." My thanks are tendered to Dr. Le Bon for his assistance; and to others from whom I quote.

‡Material, please. See Dr. Le Bon on the Ether, page 50 of this book.

external causes, though there is no comparison between the magnitude of the effects produced and their supposed causes. As to spontaneously radio-active bodies, no explanation of the same order was possible, and this is why the question set forth above remained unanswered and seemed to constitute an inexplicable mystery. Yet, in reality, the solution to the problem is very simple. Let us first of all remark that it is proved by experiments that the particles emitted during dissociation possess identical characteristics, whatever the substance in question and the means used to dissociate it. Whether we take the spontaneous emission from radium or from a metal under the action of light, or again from a Crookes' tube, the particles emitted are similar. The origin of the energy which produces the observed effects seems therefore to be always the same. Not being external to matter, it can only exist within this last.

It is this energy which I have designated by the term intra-atomic energy. What are its fundamental characteristics? It differs from all forces known to us by its very great concentration, by its prodigious power, and by the stability of the equilibria it can form. We shall see that, if instead of succeeding in dissociating thousandths of a milligramme of matter, as at present, we could dissociate a few kilogrammes, we should possess a source of energy compared with which the whole provision of coal contained in our mines would represent an insignificant total. It is by reason of the magnitude of intra-atomic energy that radio-active phenomena manifest themselves with the intensity we observe. This it is which produces the emission of particles having an immense speed, the penetration of material bodies, the apparition of X rays, etc.

The following figures will show that, whatever be the method adopted, we arrive, by measuring the energy liberated by a given weight of dissociated matter, at totals immensely superior to all those obtained by hitherto known chemical reactions—the combustion of coal, for example. It is for this reason that substances, in spite of the slightness of their dissociation, are able to produce during this phenomenon the intense effects which I have to enumerate.

The different methods in use for measuring the speed of the particles of dissociated matter, whether radium or any metal whatever, have always given nearly the same figures. This speed is almost that of light for certain radio-active emissions. For others we get a third of that speed. Let us take the lesser of these figures, that of 100,000 kilometres per second, and endeavour on that basis, to calculate the energy that would result from the complete dissociation of one gramme of any matter we please.

Let us take, for instance, a copper one-centime piece, weighing, as is well known, one gramme, and let us suppose that by accelerating the rapidity of its dissociation we could succeed in totally dissociating it.

The kinetic energy possessed by a body in motion being equal to half the product of its mass by the square of its speed, an easy calculation gives the power which the particles of this gramme of matter, animated by the speed we have supposed, would represent. We have, in fact,

$$T = \frac{0{\cdot}001^{k}}{9{\cdot}81} \times \frac{1}{2} \times \frac{\qquad^{2}}{100{,}000{,}000} = 510 \text{ thousand millions of kilogrammetres,}$$

figures which correspond to about six thousand eight hundred million horse-power if this gramme of matter were stopped in a second. This amount of energy,

suitably disposed, would be sufficient to work a goods train on a horizontal line equal in length to a little over four times and a quarter the circumference of the earth.

To send this same train over this distance by means of coal would take 2,830,000 kilogrammes, which at 24 francs a ton, would necessitate an expenditure of about 68,000 francs. This amount of 68,000 francs represents therefore, the commercial value of the intra-atomic energy contained in a one-centime coin.

What determines the greatness of the above figures and makes them at first sight improbable is the enormous speed of the masses in play, a speed which we cannot approach by any known mechanical means. In the factor $m V^2$, the mass of one gramme is certainly very small, but the speed being immense the effects produced become equally immense. A rifle-ball falling on the skin from the height of a few centimetres produces no appreciable effect in consequence of its slight speed. As soon as speed is increased, the effects become more and more deadly, and, with the speed of 1,000 metres per second given by the powder now employed, the bullet will pass through very resistant obstacles. To reduce the mass of a projectile matters nothing if one arrives at a sufficient increase in speed. This is exactly the tendency of modern musketry, which constantly reduces the calibre of the bullet but endeavours to increase its speed.

Now the speeds which we can produce are absolutely nothing compared with those of the particles of dissociated matter. We can barely exceed a kilometre a second by the means at our disposal, while the speed of radio-active particles is 100,000 times greater. Thence the magnitude of the effects produced. These

differences become plain when one knows that a body having a velocity of 100,000 kilometres per second would go from the earth to the moon in less than four seconds, while a cannon ball would take about five days. Taking into account a part only of the energy liberated in radio-activity, and by a different method, figures inferior to those given above, but still colossal, have been arrived at. The measurements of Curie prove that one gramme of radium emits 100 calorie-grammes an hour, which would give 876,000 calories per annum. If the life of a gramme of radium is 1,000 years, as is supposed, by transforming these calories into kilogrammetres at the rate of 1,125 kilogrammetres per great calorie, the immensity of the figures obtained will readily appear. Necessarily, these calories, high as is their number, only represent an insignificant part of the intra-atomic energy, since the latter is expended in various radiations.

The fact of the existence of a considerable condensation of energy within the atoms only seems to jar on us because it is outside the range of things formerly taught us by experience; it should, however, be remarked that, even leaving on one side the facts revealed by radio-activity, analogous concentrations are daily observable. Is it not strikingly evident, in fact, that electricity must exist at an enormous degree of accumulation in chemical compounds, since it is found by the electrolysis of water that one gramme of hydrogen possesses an electric charge of 96,000 coulombs? One gets an idea of the degree of condensation at which the electricity existed before its liberation, from the fact that the quantity above mentioned is immensely superior to what we are able to maintain on the largest surfaces at our disposal.

Elementary treatises have long since pointed out that barely a twentieth part of the above quantity would suffice to charge a globe the size of the earth to a potential of 6,000 volts. The best static machines in our laboratories hardly give forth $\frac{1}{10000}$ of a coulomb per second. They would have, consequently, to work unceasingly for a little over thirty years to give the quantity of electricity contained within the atoms of one gramme of hydrogen.

As electricity exists in a state of considerable concentration in chemical compounds, it is evident that the atom might have been regarded long since as a veritable condenser of energy. To grasp thereafter the notion that the quantity of this energy must be enormous, it was only necessary to appreciate the magnitude of the attractions and repulsions which are produced by the electric charges before us. It is curious to note that several physicists have touched the fringe of this question without perceiving its consequences. For example, Cornu pointed out that if it were possible to concentrate a charge of one coulomb on a very small sphere, and to bring it within one centimetre of another sphere likewise having a charge of one coulomb, the force created by this repulsion would equal 9^{18} dynes, or about 9 billions of kilogrammes.

Now, we have seen above that by the dissociation of water we can obtain from one gramme of hydrogen an electric charge of 96,000 coulombs. It would be enough—and this is exactly the hypothesis lately enunciated by J. J. Thomson—to dispose the electric particles at suitable distances within the atom, to obtain, through their attractions, repulsions, and rotations, extremely powerful energies in an extremely

small space. The difficulty was not, therefore, in conceiving that a great deal of energy could remain within an atom. It is even surprising that a notion so evident was not formulated long since.

Our calculation of radio-active energy has been made within those limits of speed at which experiments show that the inertia of these particles does not sensibly vary, but it is possible that one cannot assimilate their inertia—though this is generally done—to that of material particles, and then the figures given might be different. But they would none the less be extremely high. Whatever the methods adopted and the elements of calculation employed—velocity of the particles, calories emitted, electric attractions, etc.—one arrives at figures differing from each other indeed, but all extraordinarily high. Thus, for example, Rutherford fixes the energy of the *A* particles of thorium at six hundred million times that of a rifle-ball. Other physicists who, since the publication of one of my papers have gone into the subject, have reached figures sometimes very much higher. Assimilating the mass of electrons to that of the material particles, Max Abraham arrives at this conclusion: "That the number of electrons sufficient to weigh one gramme carry with them an energy of 6×10^{13} joules." Reducing this figure to our ordinary unit, it will be seen to represent about 80,000,000,000 horse-power per second, about twelve times greater than the figures I found for the energy emitted by one gramme of particles with a speed of 100,000 kilometres per second.

J. J. Thomson also has gone into estimates of the magnitude of the energy contained in the atom, starting with the hypothesis that the material atom is solely

composed of electric particles. His figures, though also very high, are lower than those just given. He finds that the energy accumulated in one gramme of matter represents 1.02×10^{19} ergs, which would be about 100,000,000,000 kilogrammetres. These figures only represent, according to him, "an exceedingly small fraction" of that possessed by the atoms at the beginning and gradually lost by radiation.

Under what forms can intra-atomic energy exist, and how can such colossal forces have been concentrated in very small particles? The idea of such a concentration seems at first sight inexplicable, because our ordinary experience tells us that the extent of mechanical power is always associated with the dimensions of the apparatus concerned in its production. A 1,000 h.p. engine is of considerable volume. By association of ideas we are therefore led to believe that the extent of mechanical energy implies the extent of the apparatus which produces it. But this is a pure illusion consequent on the weakness of our mechanical systems, and easy to dispel by very simple calculations. One of the most elementary formulas of dynamics teaches us that the energy of a body of constant size can be increased at will by simply increasing its speed. It is therefore possible to imagine a theoretical machine composed of the head of a pin turning round in the bezel of a ring, which, notwithstanding its smallness, should possess, thanks to its rotative force, a mechanical power equal to that of several thousands of locomotives.

To fix our ideas, let us suppose a small bronze sphere (density 8.842), with a radius of three millimetres and consequently of one gramme in weight. Let us suppose that it rotates in space round one of its

diameters with an equatorial speed equal to that of the particles of dissociated matter (100,000 kilometres per second), and that, by some process or other, the rigidity of the metal has been made sufficient to resist this rotation. Calculating the vis viva of this sphere it will be seen to correspond to 203,873,000,000 kilogrammetres. This is nearly the work that 1,510 locomotives averaging 500 h.p. apiece would supply in an hour. Such is the amount of energy that could be contained in a very small sphere animated by a rotatory movement of which the speed should be equal to that of the particles of dissociated matter. If the same little ball turned on its own centre with the velocity of light (300,000 kilometres per second) which represents about the speed of the *B* particles of radium, its vis viva would be nine times greater. It would exceed 1,800,000,000,000 kilogrammetres and represent the work of one hour by 13,590 locomotives, a number exceeding all the locomotives on all the French lines.

It is precisely these excessively rapid movements of rotation on their axis and round a centre that the elements which constitute the atoms seem to possess, and it is their speed which is the origin of the energy they contain. We have been led to suppose the existence of these movements of rotation by various mechanical considerations much anterior to the discoveries of the present day. These last have simply confirmed former ideas and have re-transferred to the elements of the atom the motion which was attributed to the atom itself at a time when it was considered indivisible. It is only, no doubt, because they possess such velocities of rotation that the elements which constitute the atoms can, when leaving their orbits

under the influence of various causes, be launched at a tangent through space with the velocities observed in the emissions of particles of matter in course of dissociation.

The rotation of the elements of the atom is moreover the very condition of their stability, as it is for a top or for a gyroscope. When under the influence of any cause the speed of rotation falls below a certain critical point, the equilibrium of the particles becomes unstable, their kinetic energy increases and they may be expelled from the system, a phenomenon which is the commencement of the dissociation of the atom.]

The motions of the surrounding ether under a rise of temperature, or increased force of movement, may cause or assist dissociation.

Illustrations are dangerous things in an argument; but, if apposite and not unduly pressed, they may be helpful.

Start one hundred men on a foot race of a mile. Soon they will fall into groups, as a result of the different rates of speed at which they travel; and tnese groups will possess mobility and stability dependent on the speed and movement of the individuals forming the groups.

Imagine an immense billiard table and a vast number of billiard balls rolling about the table; the balls will fall into groups according to the speed and movement of the individual balls, and those groups will have a sort of mobility and stability until interfered with by other groups or balls crashing against them with sufficient force and weight to break up the group, with the result that new groups are formed. What is true in this respect of masses of matter, the size of men or billiard balls, is true of smaller and larger portions of matter.

A long strip of wood usually burns slowly. The reason for this is that only the particles of those parts of the wood nearest the burning part become energised to move with sufficient speed to combine with the oxygen. The particles of the unburning portion of wood are moving too slowly to unite with the oxygen; if they were moving at sufficient speed to combine with the oxygen, the wood would be burnt up in a flash.

Every combustible substance has its *kindling temperature, at which its particles move at sufficient speed to combine with the oxygen.

One of the most difficult problems in connection with this subject is the following:—Why is it that in combustion, although the particles must move at varying rates of speed, only the products (and the same products each time) with which we are acquainted are produced? The explanation appears to be as follows: Imagine a box of billiard balls revolving rapidly, and the balls suddenly thrown therefrom at high rates of speed on to a very large billiard table; some of their movements would eventuate into groups. Repeat this as often as you like, and if the forces are exactly alike in all particulars, on each occasion you will get like results. You must have definite temperatures to produce definite chemical results, and with like forces you of course get like results. It is possible that in some cases other substances are in the act of formation, in a fraction of time, amidst the war of the atoms; but the battling of the atoms breaks up those nascent combinations before they can escape, and only those combinations remain stable and escape to which it is possible so to do under the given circumstances.

*Although they may kindle more or less slowly at different temperatures the truth remains.

The atoms having definite weights (the granules of matter must have some weight, and according to their number, or weight, in the atom so must be its weight), the resulting combination must have definite weights; and as you get like results under like circumstances, you get a like rule of combination weights.

Returning to the strip of wood, it is evident that it is the speed, weight, and movement of the atoms or molecules, etc., that give to the substance its character that we term wood. If the atoms, etc., moved at sufficient speed to unite with oxygen in combustion, it would result in and be something that certainly is not wood. They must move more slowly than the oxygen to be wood. Their rate of speed and arrangement makes them wood.

The granules, corpuscles, atoms, and molecules are continually moving, and at different speeds, through space, and as a result of contact and the exercise of force, and the action of the ether, are grouping, breaking up, and grouping again according to their speed, weight, and movement; and this speed, weight, movement and arrangement gives to substances their distinguishing characteristics. The names we give to the temporary arrangements of matter are merely words.

The granules of matter, and their accompaniments of speed, weight, movement, and arrangement are sufficient to *account for the universe, and all natural phenomena, which follow as a natural consequence of the existence of those granules and their accompaniment of speed, weight, movement, and arrangement.

Chemistry, without the aid of the speed theory, is

*From the existence of matter in motion. *See* Addenda *re* the X.

incomprehensible, as is acknowledged by its leading writers. The following, amongst its other phenomena, may be given as illustrations of the difficulty of explanation, apart from the theory. *Phosphorous at the temperature of liquid air, loses its so called affinity for oxygen, and is without action upon it; sulphuric acid, which generally acts so markedly on litmus paper, no longer turns it red. High temperatures on the other hand reveal new combinations non existent at ordinary temperatures. Nitrogen and carbon, which combine with no other bodies at low temperatures, easily combine with several at 3,000 degrees, and form bodies hitherto unknown—carbide of calcium for example. Oxygen which generally has no action on the diamond, acquires so energetic an affinity for this body, at a high temperature, that it combines with it and becomes incandescent.

†We may mix oxygen and hydrogen without their combination taking place; this only occurs at a high temperature, but then with great violence.

The combinations are clearly a result of the force of material motion, and of speed combination.

A study of the ‡atomic weights also goes far with a studious mind to assist conviction as to the truth of the theory.

The strong support given to the theory by the works of Sir William Huggins, Sir Norman Lockyer and others on the stars may be here alluded to. In the hottest stars hydrogen and proto-hydrogen are almost the only predominant elements. The energy is so great that the granules, atoms, etc., are kept

*Le Bon. †Ostwald.

‡Every well defined property of a so-called element appears to be a function of its atomic weight.—Rudorf.

at such a high rate of speed that it is impossible for them by degrees of cooling to attain such variety of speeds as to produce a great variety of combinations of substance. When all are driven at such high speed differences are eliminated, and matter appears near to its simplicity. It is the difference in the rates of speed between the very highest and the lowest, combined with the varieties of movement and arrangement and the question of *weight, which has an important bearing when the groups clash, that accounts for the many differences of material combinations of substance.

The truth of the theory is also demonstrated daily the world over by electrical accumulators. Energy, in the form of material motion, is being forced into accumulators and stored there for future use. The only way in which it is possible for this storage to take place, is in the increased speed of movement, and consequent differences of arrangement of the small portions of matter composing the chemical substances in the accumulators. When the stored up energy is run off by the current, to produce electric light, or in the performance of other electrical work, the speed of the portions runs down; and the chemical changes vary from that to this, and from this to that, as the energy is forced in or run off. A more convincing †proof it would be difficult to find in science or nature.

The term most likely to cause confusion in the mind of the reader in considering this theory is the well-known expression, gravitation; but this is merely a word for a form of force not clearly comprehended

*Or mass.

†Nature and science abound in proofs, is it necessary to fill a library with them?

by the users, and therefore to be deprecated as unsatisfying and unsatisfactory—it is, in fact, a non-explanation. An explanation may be found in the following ideas. The ether is matter, this is proved by abundant electrical phenomena, amongst the most interesting and convincing of which are, perhaps, those in connection with wireless telegraphy.* "Hertz discovered that electrical oscillations, produced in a so-called open electric circuit possessing capacity and inductance, create in the surrounding ether a disturbance which is called an electric wave. This wave can be detected at a distance by means of devices which are now termed Cymoscopes or Wave Detectors." Marconi, working on this basis laid by Hertz, utilised electric waves for telegraphic purposes. Marconi's great discovery was the importance of the antenna, or aerial wire, and of the earth connection. In its earliest form his transmitting apparatus consisted of an induction coil, one secondary terminal being connected to a plate or cylinder of wire upheld by a pole. The secondary terminals of the induction coil were also connected to a spark ball discharger; and in some of his experiments he employed a kite or balloon to uphold the elevated wire or plate, now called the antenna. In the primary circuit of the induction coil he inserted a key for breaking and making the primary current in accordance with the signals of the Morse alphabet. By pressing the key in the primary circuit of the induction coil for a longer or shorter time electric sparks of longer or shorter duration were made to pass between the spark balls of the induction coil. Corresponding to these, trains of electrical oscillations are set up in the insulated wire or strip called the

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antenna; and, corresponding again to these groups of oscillations, trains of electric waves, the duration of which corresponds with the time during which the primary circuit of the induction coil is closed, are sent out into space in all directions. At the receiving station (many miles away, and with the improved apparatus, thousands of miles away) an antenna or insulated conductor is erected similar to that at the transmitting station; and by this means the waves are intercepted and carried through the transmitter to the Morse printer, by which the message is printed off.

My point is that the action of matter on the ether by contact, producing the waves which again act by contact on matter, proves the ether to be material substance. This is also shown to be the case by the fact that *the ether has mass, since it offers resistance to movement. This mass is slight, since the speed of the propagation of light is very great. If there were no mass, the propagation of light would probably be instantaneous.

We have, therefore, surrounding the earth, an ocean of water, an ocean of air, and an ocean of ether (the ether filling all unoccupied space, but the air and water occupying only a limited area) all subject to wave motion and material movement. This wave motion in the respective oceans is caused by the motion of the material portions forming the oceans of water, air, or ether. It appears necessary to press this home, simple as it is, because there appears to be with some writers a tendency to obscure the fundamental facts under a cloud of words about the wave theory. The wave is made up of, and is caused by, the movement of many small portions of matter.

*Le Bon. Mass is the permanent and fundamental characteristic of matter. No matter without mass, no mass without matter.

The stellar and planetary bodies, rushing and revolving in their orbits, and interwhirling in themselves, through the ether, form vortices of immense scope and great power in the ether, that sweep all smaller bodies within their influence towards the path of the star or planet. Corpuscles, atoms, etc., are merely infinitely smaller bodies, all making their smaller vortices in the ether by their movement. Other granules, corpuscles, atoms, etc., moving at the same speed, approach and coalesce; the same speed keeps them moving together, assisted by the action of the vortical force set up by their movements, which helps to bind them more firmly into groups, until the groups are broken up by groups of greater weight or speed, or by the action of the ether, when new combinations are made. This explanation accounts for natural phenomena in a simple, clear, and natural manner, and eliminates confusing and non-explanatory terms, substituting in place thereof material motion and vortical force.

Let Z = an atom or molecule, Y = the ether force that keeps Z in position, A = a celestial body, B = the ether force that keeps it in position; then X million times Y will keep X million times Z in position. Therefore, as A = Z × X millions, and B = Y × X millions, B will (others things being equal) be sufficient to perform its function of keeping A in position.

At the beginning of this treatise the fundamental law of material combination was stated. Let us take up another link in the chain, and reason backwards. Imagine a growing tree, composed of many living vegetable cells, the life and growth of which depend upon sun force, that in the natural laboratory, the tree, carries on much chemical work. Sun force is material

motion. Suppose the tree to consist of one hundred million vegetable cells that owe their life and growth to sun force; then one million, one thousand, one hundred, one cell will owe life and growth to material motion; and if one cell, all cells. All the protoplasmic life and work is carried on, and depends upon the subtle movements of the granules, corpuscles, atoms, and molecules, of the protoplasm and ether; and, as there is no barrier in the protoplasm between vegetable and animal life, we arrive at the inevitable conclusion that all natural phenomena, organic or inorganic, living or dead, owe existence to material motion, and are the result of the speed of material portions, moving, grouping, re-grouping, and ever changing under the rule of material motion, in a succession of dancing and resting pictures and problems of exquisite intricacy, variety, and beauty.

Some may ask: If that be so, why is it that material motion does not now originate life on the earth? It is not absolutely certain that it does not; but if it no longer does so, the reply is, that circumstances are not now favourable; the *earth has cooled the material movements of its particles, atoms, etc., are slower. At one time, when it was hotter, and the movements were more rapid, this earth must have been a vast hot-bed for the production of vegetable and animal life.

"One fundamental fact in plant physiology practically contradicts the assumption that life has never originated from inorganic substances; namely, at the present time living substance is being continually formed in the plant cell from simple inorganic com-

* The sun has also cooled.

pounds, carbonic acid, water, sulphates, nitrates, etc., Between the small seed put into the earth in the spring and the huge plant that grows from it during the summer, an enormous quantity of living substance has been formed out of the purely inorganic substances of the environment, and when winter comes, almost the whole quantity of this living substance returns again to simpler inorganic compounds. It is here seen how inseparably related are inorganic and organic nature, how living substance is originating continually from lifeless substance, and is continually being decomposed again into lifeless substance. Nageli ('84) one of the most talented botanists, says rightly:—'One fact—that in organisms inorganic substance becomes organic substance, and that the organic returns completely to the inorganic—is sufficient to enable us to deduce by means of the law of causation the spontaneous origin of organic nature from inorganic.' If in the physical world all things stand in casual connection with one another, if all phenomena proceed along natural paths, then organisms, which build themselves up from and finally disintegrate into the substances of which organic nature consists, must have orginated primitively from inorganic compounds. To deny spontaneous generation is to proclaim a miracle." (Verworn.) When we think of the beginning of organic life we must not think primarily of carbonic acid and ammonia; for they are the end of life, not the beginning. The beginning lies rather in *cyanogen. Hence the problem of the origin of living substance culminates in the question: How does cyanogen arise? Here, organic chemistry presents the highly significant fact, that cyanogen and its compounds arise only in an

*Cyanogen, *see* Addenda.

incandescent heat, *e.g.*, when the necessary nitrogenous compounds are brought in contact with burning coal, or when the mass is heated to a white heat. Accordingly nothing is clearer than the possibility of the formation of cyanogen-compounds when the earth was wholly or partially in a fiery or heated state. Moreover chemistry shows how the other essential constituents of proteid, such as the hydrocarbons, the alcohol radicals, etc., can likewise arise synthetically in heat. It is seen how strongly and remarkably all facts of chemistry point to fire as the force that has produced by synthesis the constituents of proteid. In other words life is derived from fire, and its fundamental conditions were laid down at a time when the earth was still an incandescent ball. (Pfluger).

Life, be it said, is an arrangement of suitable materials, by material motion, in suitable form, moving within certain rates of speed. Too much speed, and death ensues. Too little speed also causes death.

Heat, light, colour, and sound are sensations caused by material motion. *Thought is also a sensation, arising from the same cause. Increased motion causes the sensation of heat; the motion is conveyed to the brain, giving the sensation of thought, and we think that it is hotter. As a result of the sensation of thought, we think, or have the sensation that we are; we cannot think that we are not.

Freely moving matter is free; all its temporary bonds are doomed to destruction. Thought, being the product of freely moving matter, must also be free. Efforts have been made to bind and tame it, but all the petty efforts of man to confine Nature end in time

*Read "Mental Evolution in Animals and Man," by Romanes.

in failure; she rends and consumes the bonds in the majesty of her progress. Free thought, by its clashing and warring, speeds thought to greater brilliance, or cools it to more tempered and exact argument, and is beneficial. Even the incoherent ravings of a poor lunatic have their uses if they drive us, as they should, to a close scientific study of their causes, in order that the disorder may be alleviated or abolished. Nature is greater than we, her puny product.

The master key to the whole subject is material motion. Minor keys are: 1. The speed of material portions; 2. Like forces, with like matter, produce like results. The slightest variation in force or speed, or arrangement of matter, may give a tendency to variation in results; and this, carried far enough, accounts for the variation in individuals and species. *Darwin's work dealt more with the outward manifestation, this deals with the material power, in the form of material motion.

*The work of Darwin, Wallace, Huxley, Haeckel, and other great thinkers, mathematicians and experimenters, the whole galaxy of scientific Masters, has made this work and theory possible.

THE ORIGIN OF LIFE.

IT has been previously stated that electricity and magnetism are material motion in special forms or modes, and only in operation when material motion takes those forms or modes. Lightning is electricity. It is admitted that lightning takes the line of least resistance, as any physical force will do. This means that lightning follows the path of the best conducting material, and that it is surrounded by matter of less conductivity, it is insulated. It is not necessary to remind electricians that insulating matter may have a higher or lower rate of conductive capacity, all that is necessary for it to be able to insulate, however imperfectly, is that it should not conduct as well as the matter along which the lightning finds its path. This suggests the thought that electricity is of the nature of material motion and stress within an envelope, or it may be several envelopes with varying degrees of insulation.

This may be new, but is none the less true. Nature is in a state of continual flux, as a result the portions of matter are more closely packed (or differently arranged) in some places than in others, where more closely packed the insulation is greater, where more free the conductivity is greater, with freer electric flow, in naturally formed electrical containers, that may be termed reservoirs or cells.

The envelope may be of air, or other *matter, or of other matter within air or mixed with air. Electrical

*The Ether is matter.

engineers insert linings within their insulating covers and nature often does the same. They may have one cell, or many cells grouped in innumerable ways, that is also nature's method. At their best they only feebly follow her. Here we approach what is very suggestive with regard to wireless telegraphy. It appears probable that the motion connected with this phenomenon is electricity until it leaves the antenna, and that then it is transformed into mere material motion, in the form of wave motion of the ether, unless we make our definition of electricity too loose for practical purposes. When we look out into the infinity of nature we see the difficulty of a precise definition; heat (which is material motion) appears to shade off imperceptibly into electricity (which is material motion in a certain condition of stress), and back again from electricity to heat. This is nature's way to solve by imperceptible gradations (although she can act in cataclysms), we see it not only in this case, but in so many, in the gradations from non-living to living, of vegetable and animal, etc. Nature does not in order to oblige us continually work by creations (unless the word be used figuratively, to cover much), but by evolutions, and by imperceptible gradations to great effects. Adumbrations and gradual blendings onward to the completed picture, and gallery after gallery of simple, or intricate, and exquisite beauty. My definitions, therefore, are more for practical use, than absolutely correct.

The ether waves strike upon the receiver, and the material motion is again transformed into electricity, or material motion and stress within an insulating envelope. If this is true it gives us a beautiful illustration of the transforming of electricity into mere material motion, and of that motion again into

electricity. It also suggests what looks like a matter of great practical importance. If it is correct, it appears possible that electrical engineers will be able in the future to do without many millions of miles of that very expensive material copper wire, and that with the insertion of an antenna at one end and a receiver at the other of their insulated tube (now called cable) they may be able to force along the tube, and to store their electricity in the accumulators. The development of electric power on these lines will greatly cheapen it as a motive force, so much so that it appears bound to become the great motive force of the future. Why is it that the force that strikes the receiver is so feeble in comparison to the total force that leaves the antenna? It is evident that the reason is that the power is mainly dissipated into space in the form of material motion. If the whole of that power could be retained in a small cubical space as in an accumulator, the problem of the best electrical accumulator would be solved. We should not need to attempt the disassociation of the atom as suggested by Le Bon, we should tap the primitive ether force and store it in accumulators to be used as required. Nature does it, and it should not be beyond the powers of science. Experiments have been made in this direction by the writer, but his resources, and abilities as an experimenter, are not equal to the task. The question is, however, of such overwhelming importance that he hopes that some organised attempt may be made by the Scientific Societies for its solution.

But to return to our main subject. Nature's method is the eletcro-magnetic, cell mode, she is constantly forming non-living, as well as living cells; and if the adage "all cells from cells" is true, as no doubt it is,

the living cells must have proceeded from the non-living. The mistake has been in not carrying the cell theory into inanimate as well as animate nature, thus making the cell theory true to nature. Electricity is material motion and stress within an envelope. If the enveloping matter is not sufficiently strong, has a weak spot, a breach occurs, and the electricity rushes into what, if the insulation is sufficient, becomes another insulated container of electric power (say a reservoir or cell) and this process is continually going on in nature, and must do so, is inevitable from its constitution and motion; and is one of its most constant processes. Cells, or containers, of many shapes and sizes are continually being formed and broken up, both in inanimate and animate nature. The whole business, including the electrical stress, is caused by portions of matter in motion.

We know that all things that have reached the molecule stage are more or less magnetic, and consequently electric; and it is doubtless also true of the atomic stage. Portions of matter meet, clash, and thereby set up a revolution of the portions, and cause electrical and magnetic effects; and some of these in that condition of motion, as a result of their movements, form around themselves an envelope or skin, or skins, which may be of air, or other matter, within which the electrical and magnetic stresses and effects are produced. Much depends on the quality and strength of the skin, what I term "power of skin." In many cases of inanimate phenomena, and in primitive forms of living matter, when the internal stress becomes too great for the power of the envelope or skin, it stretches; and at its weakest point a rupture takes place, a daughter cell is formed by breaking away from

the parent mass; and the mother cell as a cell perhaps perishes, or, as in some cases, two cells are formed. There are many forms of division of cells, with various results. In the case of some others the power of the skin is sufficient to resist dissolution (although cells may be multiplied by division within) but not to resist the distortion of its shape, and consequently, depending on the pressures within and without, and the power of the *skin, we get an immense variety of form and size of both non-living and of living matter. It is the power of the skin, combined with the pressures within and without, etc., that gives us great trees and large animals, and such an immense variety of trees and animals. The power of the skin, and the capacity to form it, is also one of the great secrets of †heredity, and the differences of the power of the skin, etc., is that which allows of such great variation. But it is not only the power of the skin, there is also the question of the ‡size of the cells. The cells of some things are larger than the cells of others, and contain a larger quantity, if not a better quality, of nutrient matter; and consequently the daughter cells are larger, and as they increase and grow you get a larger object. There is more, however, than the mere question of size, there is likeness. Why an elephant and not a fish? The reply is that it is a question of the most delicate play of complex physical forces. Every reproductive cell, if it could be seen in its entirety, has its distinctive points and potentialities; and within and without are

*Take the word skin as meaning envelope.

†Heredity, and Weismann's germ-plasm, *see* Addenda.

‡Physiologists would, perhaps more correctly, say that cells are generally nearly of the same size; but some are larger and some smaller; and that bulk is caused by increase of either.

working forces that under similar conditions have only one result, limited in extent, and *definite in end, so that with mathematical precision they produce effects that follow one another to a certain conclusion. Variation is caused by interference with those conditions or forces.

The question of †sex, after its first evolution, appears to depend upon the virility of the parent cells. If the male reproductive cell is the more virile it will be the dominant factor and *vice versa.* When families are mixed in sex it results from the swing of the pendulum of virility between the reproductive cells. Physiologists know how many things go to produce virility, constitution, food, air, etc.

A living cell is an electro-magnetic, and an electro-chemical machine, within an envelope, and living organisms of a higher type are electro-magnetic and electro-chemical machines containing within an envelope many such small machines, the combined effects of which give the necessary electro-magnetic and electro-chemical forces to produce motion, and the other phenomena characteristic of living things, aided by various stimuli, such as heat, etc. The whole being material motion; but motion at various speeds and in many ways.

The electrician forms a battery by putting a plate of copper and a plate of zinc into a suitable fluid, and electro-chemical results follow. When he withdraws the fluid from the cell the results apparently cease. It is the speed of movement, and arrangement, of the portions of matter in the copper, zinc, and the fluid

*Definite in end in the sense that given certain conditions and forces certain results must follow.

†Sex. Read Professor J. Arthur Thomson's "Heredity," page 476.

that produces the electro-chemical effects. Nature, like the electrician, puts her positive and negative materials within her living cells, that she has formed by enveloping the materials in some species of envelope, and adding a suitable fluid, electro-chemical results follow. When by the operations of nature the fluid is withdrawn, the results apparently cease, and the cell or cells (or seeds) appear lifeless; but when she again supplies the suitable fluid under suitable conditions they again give the electro-chemical phenomena of life, unless they have been left long without fluid, and the molecular clockwork has, while without the fluid, run down below the energy, or speed of movement, necessary to the manifestation of electro-chemical effects when the fluid is again added.

It is evident that **it is only necessary for a cell in inanimate nature, that contains the necessary materials, having the needful energy, within an insulating envelope, to be supplied with the suitable fluid for the phenomena of life, under suitable conditions, to be manifested.** How simple after all is the origin of life, the difficulty has been in our want of understanding. It may be a little difficult at first glance to see in all its fulness and beauty; but when we remember that the difference between life and death in the seed, and cell, is really the difference between the feebleness and swiftness of movements, in various ways, of small portions of matter the subject becomes quite easy. If they move at sufficient speed, on the addition of the needful fluid, life is manifested; if the speed of movement is too feeble it is death, they are inanimate, life is consequently at bottom a question of speed.

The difference between the living and the non-living is the capacity possessed, as a result of speed, by the

living to produce the electro-chemical and other effects within their cells that result in growth. Nevertheless the living are not independent, they also are dependent on external as well as internal physical law, they are electro-chemical machines connected with and controlled by the great machine nature; and perhaps the best definition of life is that it consists in an arrangement of suitable materials, by material motion, in suitable form, moving within certain rates of speed. As we approach the borderland between animate and inanimate nature it is almost as difficult to separate the living from the non-living as it is to distinguish between the animal and vegetable; and it is a question whether we ought not to extend the definition of life to include much that is now regarded as not living, although perhaps much harm may not be done if we remember the difficulty of drawing an abrupt dividing line between the two Kingdoms. They appear to be imperceptibly merged in one another. This is nature's way and may be taken to be one of the indications of the unity of nature, and her rule of natural law. You may not like it, you may prefer what looks to you more clear and definite; but nature declines to work according to our dictation, she has her own inimitable way of gradual and imperceptible mutation.

The great physiologist Verworn writes that:—"The fact stands out clearly and distinctly that life from its beginning has been dependent upon the external conditions of the earth's surface. In a mathematical sense, life is a function of the earth's development. Living substance could not exist while the earth was a molten sphere without a solid, cool, crust; it was obliged to appear with the same inevitable necessity as a chemical combination when the necessary con-

ditions were given; and it was obliged to change its form and its composition in the same measure as the external conditions of life changed in the course of the earth's development. It is only a portion of the earth's matter. The combination of this matter into living substance was as much the necessary product of the earth's development as was the origin of water. It is an inevitable result of the progressive cooling of the masses that formed the earth's crust. Likewise, the chemical, physical, and morphological characteristics of existing living substance are the necessary result of the influence of the external conditions of life upon the internal relations of past living substance. Internal and external vital conditions are inseparably correlated, and the expression of this correlation is life." The whole being caused by material motion. When the earth and its surroundings are sufficiently cold, when material motion is too feeble for the manifestation of life, vital phenomena on this planet will cease to exist.

The subject is so vast and so exquisitely beautiful that one might write for ever, and there is a danger of eloquent gush; but I spare the reader.

Some persons may fear to amend the Newtonian philosophy, lest some great catastrophe happen. They may argue: "How can I give up this idea? What was to keep matter together before this universe was evolved, and what is to keep matter together if the universe be destroyed?" I think that we can ease their minds. Space is illimitable, and eternity has neither beginning nor end. Eternal space is all space. Matter cannot possibly drop out; there is nowhere for it to drop to. Instead of needing holding together, it needed the very reverse—the freest possible opportunity of movement, which is allowed to it by

my theory, then vortication, as developed, keeps it together, or unlooses it, under physcial force and law, as nature in her working compels.

Our finite thoughts are apt at times to be petty, and to move in a groove. In dealing with natural philosophy we need to overcome this style of thought—to give wings to our instructed imaginations, that we may realise the exquisite and infinite beauty and grandeur of nature. Free moving matter* may have, during eternity, evolved unnumbered universes and peoples before our present one that will dissipate to dust; and †from that dissipated freely moving matter countless universes and peoples in succession may be evolved, speeding on in never-ending cycles of beauty, majesty, and glory, perhaps towards perfection, when shame and sorrow shall be no more; but, in any case, in an endless chain of intricate loveliness, dazzling brilliance, and gorgeous beauty. Finally, whatever the original cause of motion, the speed theory must be true, because two portions of matter moving adjacent to one another along a straight line at equal rates of speed must continue to move together so long as their speeds remain equal and they do not receive any interference. This, firmly grasped and rightly applied, is the key to unbar the way into paradise after paradise of nature; and reveal the hidden beauties of her varied and secret work.

May sweet reasonableness, courtesy, and peace be with us evermore.

*The potential existed.

†*See* Addenda, for maintenance of energy.

AFTER THOUGHTS.

NATURE teaches in no uncertain way the principle of natural evolution,* illustrations are continually before our eyes, and the doctrine has passed as a truism into our literature, and is taught in our schools. †Atoms, molecules, suns, stars, planets, plants, animals, and man have been evolved by natural processes; and consequently the thoughts, emotions, works, and religions of men.

Many centuries before the time of our earliest records the parent race of the Aryan races—the Hindus, Persians, Greeks, Romans, Kelts, Teutons, and Sklaves—had passed through the earliest phases of its religious beliefs.

Persia, or Iran, are in modern political geography synonymous terms; the kingdom which we call Persia the Persians themselves call Iran. The name Iran, on the other hand, was originally of much wider signification than Persia, and the whole upland country from Kurdistan to Afghanistan may, in

*The idea that all the varied structures in the world, the divergent forms of rocks and minerals and crystals, the innumerable trees and herbs that cover the face of the earth like a mantle, and all the animal host of creatures great and small that dwell on the land or dart through the air or people the waters—that all these had arisen by natural laws from a primitive unformed material was known to the Greeks, was developed by the Romans, and even received the approval of the early Christian Fathers, who wrote long before the idea had been invented that the naive legends of the Old Testament were an authoritative and literal account of the origin of the world.—"Thomas Henry Huxley," by P. C. Mitchell.

†Aristotle, in Physics II., 8, wrote, "Why are not the things which seem the result of design, merely spontaneous variations, which, being useful, have been preserved, while others are continually eliminated as unsuitable?"

accordance with the native use of its ancient inhabitants, be called the Iranian upland. The inhabitants of this upland, together with certain tribes of the same race in other lands, shared with their near kinsmen in India the name of Aryans.

Attempts have been made with considerable success to argue from the words and beliefs found, in their earliest records, to have been common afterwards among one or more of the seven races, to the religious ideas which must have existed in the parent stock. *The beliefs of our remote ancestors may be summed up as having resulted from that curious attitude of mind which is now designated by the word Animism. They had come to believe, most probably through the influence of dreams, etc., in the existence of souls, or ghosts, or spirits inside their own bodies; and they had not yet learned to discriminate in this respect between themselves and the other animals and objects around them which seemed to be possessed of power and movement. In due course they produced written records, some of these have survived in the form of Vedic hymns. The Vedas, though they are amongst our earliest records, show us only a very advanced stage in the beliefs resulting from an Animistic frame of mind. The more powerful spirits or ghosts supposed to dwell in various external things, have become in the Vedas objects of greater fear than the rest; they are endowed with higher attributes, are surrounded by deeper mystery, and have been promoted to be kings, as it were, among the gods. These were chiefly the spirits supposed to animate, or to cause, the sky and the heavenly bodies; and the promotion of these

*Read the works of E. B. Tylor, T. W. Rhys Davids, Max Muller, Rev. A. H. Sayce, Dr. Isaac Taylor, etc.

spirits had so dimmed the comparative glory of the rest, that the Animism becomes in the Vedas what we call Polytheism. The newer stage of belief was not a contradiction of the older; it was simply a further advance along the same lines, and resting on the same foundations. The lesser spirits, or at least most of them, survived as naiads and dryads, spirits of the streams and trees, demons, goblins, ogres, spirit-messengers, and fairies, good or bad. And the old belief in mysteriously animated objects survived, too, in the belief in magic, in sorcery, and in charms of various kinds.

The Vedas are the source of two vast currents through the ocean of religious thought, one of which flows by way of the Rig Vedas, Upanishads, etc., through Brahmanism (a system of religious institutions, originated and elaborated by the Brahmans) to Buddhism; and the other by way the *Zend Avesta through the Accadian, Semitic, and Hebrew religions to Christianity.

Buddha altogether denied the revealed character of the Veda, and the efficacy of the Brahmanical ceremonies deduced from it, and rejected the claims of the Sacerdotal class to be the repositories and divinely appointed teachers of sacred knowledge. †The distinguishing characteristic of Buddhism was that it started on a new line, that it looked on the deepest questions men have to solve from an entirely different standpoint. It swept away from the field of its vision the whole of the great soul-theory which had hitherto

*The religious ideas indicated in the Vedas and Zend Avesta combined with a more Primitive Animism and Shamanism, etc., were more or less the ideas of the peoples dwelling in the mountains of Media and the valleys watered by the Tigris and Euphrates.

†T. W. Rhys Davids.

so completely filled and dominated the minds of the superstitious and of the thoughtful alike. For the first time in the history of the world, it proclaimed a salvation which each man could gain for himself, and by himself, in this world, during this life, without the least reference to God, or to gods, either great or small.

Like the Upanishads, it placed the first importance on knowledge; but it was no longer a knowledge of God, it was a clear perception of the real nature, as they supposed it to be, of men and things. And it added to the necessity of knowledge, the necessity of purity, of courtesy, of uprightness, of peace, and of a universal love. The Buddhist was to let his mind pervade one quarter of the world with thoughts of love, and so the second, and so the third, and so the fourth. And "thus the whole wide world above, below, around, and everywhere, does he continue to pervade with heart of love, far-reaching, grown great and beyond measure."

The Buddhist doctrine is, try to get as near to wisdom and goodness as you can in this life. Trouble not yourself about the gods. Disturb yourself not by curiosities or desires about any future existence. Seek only after the fruit of the noble path of self-culture and self-control. Early Buddhism had no idea, just as early Christianity had not, of the principle underlying the foundation of the higher morality of the future, the duty which we owe, not only to our fellow-men of to-day, but also to those of the morrow —to the race as a whole, but in the future even more than now. Buddhists and Christians may both maintain, and perhaps rightly maintain, that the duty of universal love laid down in their Scriptures can be

held to involve and include this modern conception; but neither the early Buddhists nor the early Christians looked at the matter quite in this way. The sense of duty to the race has sprung out of a fact only lately become a generally received conception—the progressive continuity of human progress. And the corresponding doctrine of Buddhism is not that "the thoughts of men are widened with the process of the suns," but that there are recurring cycles of improvement and decay. It is true that the Buddhist duty of universal love is much more far-reaching as regards the present than the corresponding duty as commonly received in any other religion. It enfolds in its ample embrace not only the brethren and sisters of the new faith, not only our neighbours but every being that has life. "As a mother, even at the risk of her own life, protects her son, her only son, so let a man cultivate goodwill without measure toward all beings. Let him cultivate goodwill without measure—unhindered love and friendliness—toward the whole world, above, below, around. Standing, walking, sitting, or lying, let him be firm in this mind so long as he is awake: this state of heart, they say, is the best in the world."

The Zend Avesta is the original document of the religion of Zoroaster, and is still used by the Parsees as their Bible and prayer book, and was written in pahlavi. Pahlavi means Parthian. This fact points to the conclusion that the system of writing was developed in Parthian times, when the great nobles, the Pahlavans ruled, and Media was their main seat, "the Pahlav country." The political and military institutions of the Persians are substantially those of the Medes; even the dress (of the Persian troops) was borrowed from the Medes.

The ideas indicated in the Vedas and Zend Avesta, combined with a more primitive Animism, and Shamanism, were more or less the ideas of the peoples dwelling in the mountains of Media and the valleys watered by the Tigris and Euphrates. *About three thousand years before our era, the fertile plain of Babylonia was under the domination of the Accadians, though the Semitic nomad and trader were already beginning to make their appearance. The country was divided into two provinces, the northern called Accadia, and the southern Sumir, or Shinar, in which two separate though closely allied dialects were spoken. About two thousand years B.C., the Accadian was gradually superseded by the Semite, and before long the Accadian language itself became extinct, remaining only as the sacred and learned language of religion and law. The Semitic Assyrian adopted and gradually transformed the religion of the Accadians, and became the dominant power in Chaldea. Abraham, a Semite, came out of Ur of the Chaldees; and the religion of the Semitic Assyrian Chaldeans became in a modified form the religion of the Hebrews. The word for †Sabbath in the Hebrew Old Testament is an Accadian word, and the ritual is in the main similar to the Accadian ritual. The religion of the Hebrews developed, under the teachings of Jesus of Nazareth, and his Apostles, into Christianity, and the key-note of Christianity, as of Buddhism, is love.

No matter what differences of opinion there may be with regard to the foregoing account of the growth of

*Rev. A. H. Sayce.

†And the word Elohim (Gods) is plural (the translation "God" is an arbitrary translation) probably pointing to an early use in that plural sense.

religious thought, all will agree with the conclusion that those two religions exalt love.

Christendom, and Buddhadom, have been compared to large trees, and their tap roots go down to the Aryans and their Vedas, and even deeper to a still more primitive form of religious thought.

Confucianism, and the Greek philosophies, if they did not attain to the fullness and beauty of the theory of love developed in Buddhism and Christianity, at least gave indications of an idea of that principle; and in the religion of ancient Egypt* traces of the idea, if not the word, however faint and elusive, may be said to exist. This principle of love is a later and more cultured development of earlier religious thought, found embedded, in the written religions, in a setting of more primitive ideas.

Max Muller has given us definitions, etymological, historical, dogmatic, and otherwise of the word religion; but what is wanted to be known is, what is religion? Writing without authority, and purely from the point of view of a student, who has given thought and study to this vast and interesting subject, it appears that †religion may be said to be **love, in activity.** The higher written religions seem to sanction this definition, and one, at least, of those religions was written with a view to promoting the activity of love; and informs us that it is the supreme test by which a man may know if he is truly religious; and it also forms an important part of Buddhist teaching. The written religions are comparatively

*Andrew Lang appears to think that this is true of the religion of some savages.

†Not so much historically and comparatively, as essentially, and apart from the more primitive ideas.

modern; for countless ages before their production, men and women lived,* loved, mated, and reared in love their offspring, must have done so or the race would have perished, and were in the doing so (in spite of many shortcomings) truly and beautifully religious; and that as a necessity of their being. They could not, in a sense, help it any more than the sun could help shining. Love for ones own flesh and blood, and ones fellows is the very essence and perfection of religion, and it is the result of the natural evolution of the emotions of men and women. Love, however, is not only a natural product, it is an art, which like other arts may be much assisted, in its individual manifestation, by stimulation, education, study and practice. It is natural that in the process of this slow and gradual evolution of man, thoughts, habits, and customs, more or less imperfect and unbeautiful, should have been manifested both in his ways and in his written words. The product being imperfect men and imperfect religions. But in this as in other things, the survival of the fittest holds good. The unfit may linger on, both in practice, and enshrined amongst the fit in written records; but that which is unfit will eventually be cast off, like autumn leaves, to find a deserved oblivion, and the fit, the useful, and the beautiful, will survive. The most beautiful of all, the essence and the sum of true religion and morality, love will survive, and go on to perfection. It is here that natural and written religion, and philosophy, that all shades of

*In spite of many hindrances, and quaint customs, referred to, and not alluded to, in Lord Avebury's interesting book "The Origin of Civilisation," and other works. Love gradually triumphed and it is hoped will continue to triumph over all. The evolution of sex (combined with other aids), is the great instrument by which Nature has gradually and almost imperceptibly wrought this great work.

thought and peoples, meet, to join in the promotion of the manifestation of love to man, to the gradual elimination of differences; and the evolution of pure and true religion, love in activity, unhindered, as far as possible, by the crude superstitions, or errors of thought and conduct of partially evolved humanity. We cannot love too well, and too wisely, it is the life beautiful. I know of no better book to read (with the salt of common sense, and in the light of knowledge) on this subject than the New Testament,* supplemented, as far as possible, by wide reading in other religions and directions), therein love is indeed an art, developed in connection with one of the most beautiful poetic tragedies that the world has ever read, and illustrated by the most superb devotion on the part of many of its disciples. Men are still in process of evolution, some being much more backward than others; but as their environment is improved, and they respond more fully thereto, aided by its beneficent stimulants, we may hope that the unbeautiful may fade and fall away, to the manifestation of one of nature's greatest works, noble manhood. This is the ideal to which nature is working, and art is aiding; and all that is best and true is living to attain. Meanwhile tolerance, patience, mutual sympathy and help are needful, while we learn to live the life beautiful, and acquire knowledge and wisdom.

*"Ethics and Religion," published by Swan, Sonnenschein & Co., is a useful book.

ADDENDA.

N.B.—The sense in which the word "vortices" is used is as expressing the motions communicated to the surrounding ether by the rush and whirl of the stars, planets, atoms, etc., resulting in vortical force.

Cyanogen, this is merely a name for an arrangement of material portions, moving at certain speeds, in certain ways; and consequently having certain characteristics. Never let either simple or difficult words blunt your perception of this fundamental truth about substances.

Physicists, Geologists, etc., know that many modifications of physical law are brought about by physical law, by the formation of cements, by pressures, etc., etc. These have not been mentioned in detail. I have given the outline, the filling in and decoration is left to abler hands to perform at their inclination and leisure.

Maintenance of energy. Professor S. Arrhenius is the author of one theory on this subject, and there are others. The potential is acknowledged to exist.

Recapitulation. The author has endeavoured to show that, "All *mass is mass of the ether, all momentum, momentum of the ether"; and that the ether is matter. Change is caused by material motion, and collisions of the masses, or the ether. Electricity and magnetism are material motion in a certain condition of stress. Gravitation is a result of vortication caused by the natural motions of the ether, and the ether masses. All resulting in inanimate and animated nature as at present existing and changing.

The X, or original cause (if any) of matter, in motion, is left open to speculation and proof. Predicate what you may as to this, the mode of expression, the natural manifestation (in a material universe and with material beings) is by material motion.

* Professor Sir Joseph John Thomson, Cavendish Professor of Physics, Cambridge.

Heredity. Weismann's "unalterable" germ-plasm. The chromatin, Professor Weismann says, grows. A tree also grows, and from other matter forms, by physical force and law, what we term wood, and a tree, but talk of unalterable trees would not be a satisfactory explanation, or strictly true; and as something does not grow out of nothing in living cells, the chromatin grows out of other matter that becomes chromatin. Nature, according to Weismann, is continually making new chromatin, and has been doing so from the first appearance of that substance. The word "unalterable" used, in an unrestricted sense, with regard to chromatin is consequently incorrect. It is evident that the chromatin is alterable, in the sense that the fresh chromatin is new chromatin, made out of other matter than the old.

Another point is, that to say that the germ-plasm is the cause of heredity (although it may be interesting biologically) cannot be regarded philosophically as a satisfactory explanation, as we shall see if we examine the subject closely. Germ-plasm is merely a compound word applied to certain arrangements by nature of material portions moving at certain speeds and in certain ways, acting and reacting on one another, and upon and by material forces within and without the cells. Weismann draws attention to the importance of these forces, in the cases of pigeons, ivy, etc, and it is not difficult for the student (if he is not led astray by an "unalterable" theory) to sift from the other interesting statements and arguments, etc., in Weismann's learned book sufficient to make it clear that the only satisfactory explanation of heredity, and other natural phenomena, is that given in my theory of material motion as developed in my treatise.

Leakage of Life. The author is glad to receive evidence that his theory is making headway in scientific circles. In proof of which he gives an extract from the *Daily Mirror* of 20th September, 1909:— "We are exhilarated by a dry atmosphere; depressed by a damp one," Dr. A. F. King writes in the current number of the *Popular Science Monthly*, "because the moist air, being a conductor, carries off some of our electricity to the earth, while dry air is a more complete insulator, and prevents this leakage."

An eminent medical scientist interviewed by the *Daily Mirror* bore out this statement, and explained that it was due to the fact that man was a complicated machine run by electricity.

"The human body," he said, "is built up of innumerable cells. Each of those cells has life, and is, in itself, a tiny electric battery operated by weak chemical reactions.

"Life can, therefore, be defined medically as the electrical outcome of weak chemical interchanges conducted in the body by the circulation of the blood, which carries oxygen to produce these electrical changes.

"This is true, because if you stop the supply of oxygen you stop these chemical reactions, the electrical output of the cells ceases, and death is instantaneous.

"Therefore, the electrical forces of the cells are an essential phenomenon of the orderly life of the whole body, and they supply energy to the brain and nervous system.

"Enveloping all these billions of cells is the skin, and the resistance of the *skin to the electric current is enormous. In the ordinary way skin may be said to be an absolute non-conductor.

"Now, on a humid day the water in the atmosphere—water is one of the best conductors of electricity known—destroys this insulation of the body, and allows the electricity it contains to escape.

"The skin becomes damp, and the minute globules of water in the air form millions of conducting chains, which lead the electrical forces of the body—in other words, its life itself—to the earth.

"As a result a new burden is imposed upon the vital processes of the man (or animal). They must repair the waste of electricity, and the consequence is that a 'slack' feeling is produced which is really the symptom of the wastage of vitality.

"This is extremely marked on a hot, moist day, for the excess of slightly saline perspiration is exceedingly favourable to a very pronounced leakage.

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* And the dry air in which it is enveloped on a dry day.

"On a dry day all that the system has to contend with is the natural loss of tissue caused by ordinary exertion; there is far less wastage of vitality and a consequent feeling of superabundant energy. Hence the exhilaration of mind and body.

"The troops in South Africa, for instance, describe the dry air of the high veldt as being 'like champagne' in its effect upon them.

"It may safely be said that the effect of a damp, gloomy day is to deplete the system of life."

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